Comments on ASCE 7-16 Chapter 6 Tsunami Loads and Effects

For public testimony to OSSPAC, September 10, 2019
Initial draft provided for Oregon Tsunami Line Working Group, 2019

Daniel Cox, Ph.D., M. ASCE
Professor, School of Civil and Construction Engineering Oregon State University
Voting member, ASCE 7-22 Chapter 6 Tsunami Loads and Effects Subcommittee

Q1: What is ASCE 7-16?

- ASCE 7-16 provides requirements for general structural design of new buildings and other structures. It provides engineering with the means to calculated forces from hazards such as high winds, hurricane surge and wave, inland flooding, snow and ice, and earthquakes.
- Chapter 6 applies to tsunamis and is new for the current revision cycle.
- "16" stands for "2016", the year of the current revision cycle. The ASCE 7 standard is on a six year updating cycle. The next update is scheduled for 2022. Each revision goes through an extensive review and balloting process.
- ASCE stands for "The American Society of Civil Engineers". The ASCE 7 is produced by volunteer members working in committees. The committee membership includes practicing engineering, producers of material used in construction (e.g., concrete, steel, timber), regulators, and other people including university researchers.

Q2: What buildings and structures are covered under ASCE 7-16 Chapter 6?

- ASCE 7-16 Chapter 6 applies to NEW construction of Risk Category III and Risk Category IV structures.
- Risk Category III includes buildings where the failure poses substantial risk to human life. Examples include elementary schools, day-care centers, university buildings, jails, health care clinics, buildings intended for large public assembly, structures with a large occupant load (> 5000), power-generating stations, water-treatment facilities for potable water and wastewater treatment.
- Risk Category IV includes essential facilities. Examples include hospitals, fire and police stations, designated emergency shelters, emergency generation and communication facilities and vertical evacuation refuge structures.
- Risk Category I and II structures are not included in ASCE 7-16 Chapter 6. Small hotels, office buildings, condominiums, and parking garages are not included in ASCE 7-16 Chapter 6 **unless they are used for vertical evacuation**. Residential structures are not included in any part of ASCE 7-16.
- The Provisions do not apply to EXISTING buildings unless the building is an existing Category III or IV building which undergoes a significant expansion where the weight of the building

increases by greater than 10% OR the building is a Category I or II building which undergoes a change of use to a higher hazard Category III or IV building.

Q3: What is the difference between the ASCE 7-16 Chapter 6 and the DOGAMI inundation lines?

- The ASCE 7-16 Chapter 6 tsunami inundation hazard uses a **probabilistic approach** and is based on a 2475-year recurrence interval. The same recurrence interval is used to define the earthquake hazard in ASCE 7-16. The DOGAMI tsunami hazard is scenario-based and consists of five different lines all of increasing size that represent different possible Cascadia scenarios. The ASCE 7-16 Chapter 6 tsunami inundation hazard can be compared to the DOGAMI "M" or "L" scenario in the two cases shown below (Newport, OR; Seaside, OR).

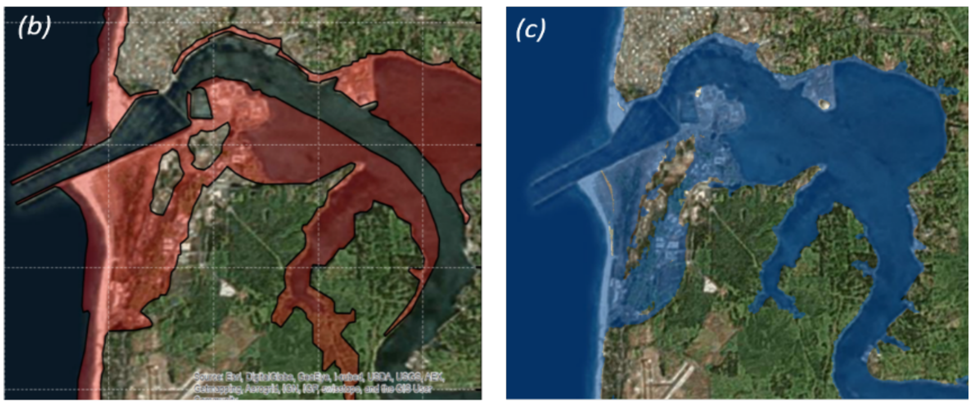

Figure 1: Comparison of the tsunami inundation hazard for Newport, Oregon, for ASCE 7-16 (left) and DOGAMI "M" scenario (right)

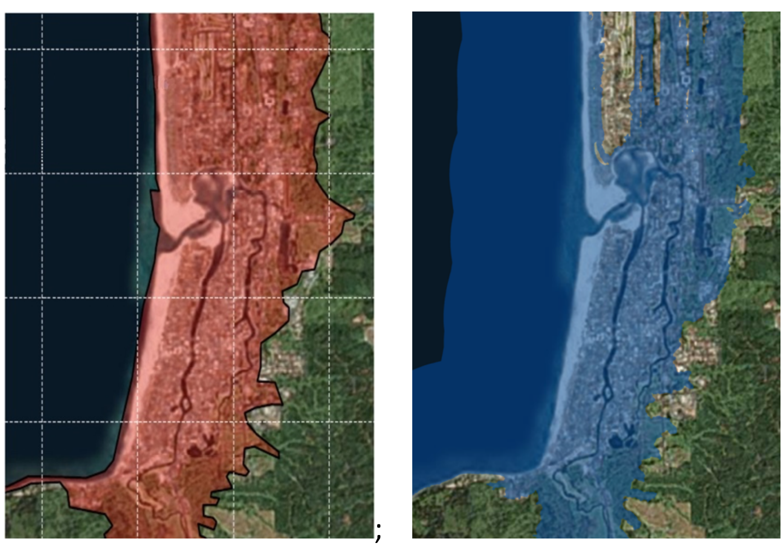

Figure 2: Comparison of the tsunami inundation hazard for Seaside, Oregon, for ASCE 7-16 (left) and DOGAMI "M" scenario (right).

Q4: What is the benefit of the ASCE 7-16 Chapter 6 approach?

- ASCE 7-16 provides a consistent approach to designing against all natural hazards including earthquake, wind, flood, snow and ice, and tsunami.
- ASCE 7-16 is used by practicing engineers for engineering design of new structures and is adopted by BDS as a reference standard of the International Building Code (IBC) which forms the basis for the Oregon Structural Specialty Code (OCSC) . It is not a statutory document.
- ASCE 7-16 provides for a **variation in the tsunami hazard** geographically similar to what is done for earthquakes.

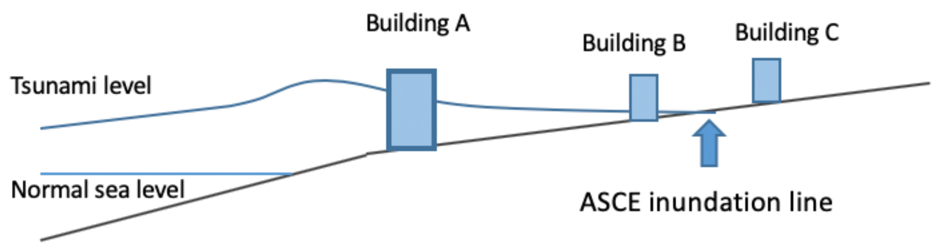

Figure 3: Variation in tsunami hazard and how it can affect building design.

- With the ASCE 7-16 Chapter 6 approach, there would be little difference between Building B located just inside the tsunami inundation zone and Building C located just outside the tsunami inundation zone. Building A at the shoreline would be subjected to a higher tsunami hazard level comparted to Building B.

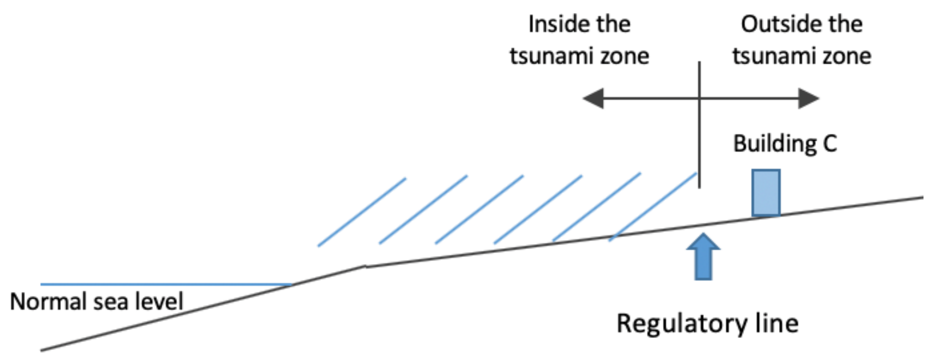

Figure 4: Conventional regulatory approach.

- With a regulatory approach, there is no consideration of how the tsunami hazard changes in the inundation zone. There is no difference in hazard level from the shoreline to the most landward extent of the tsunami inundation zone.

Q5: Are there examples of buildings designed with ASCE 7-16 Chapter 6?

- Yes, there are two engineered structures that have been designed using ASCE 7-16 Chapter 6 and provide for vertical evacuation refuge: a portion of the Ocosta Elementary School on the Washington coast and Oregon State University's Marine Science Center building in Newport, Oregon.

- The gymnasium portion of the Ocosta Elementary School was designed using ASCE 7-16 Chapter 6 to withstand the tsunami forces and provide for vertical evacuation of students and the neighboring community. The cost of the strengthening of the gymnasium roof to support 1000 people was about $2M on a total project cost of $14M (15%).

- Oregon State University's Marine Science Building Newport, OR, is currently under construction. It was designed using ASCE 7-16 Chapter 6 to withstand the tsunami force and provide for vertical evacuation. The cost of accommodating the tsunami features in the structural system was about 3% of the total project cost.